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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

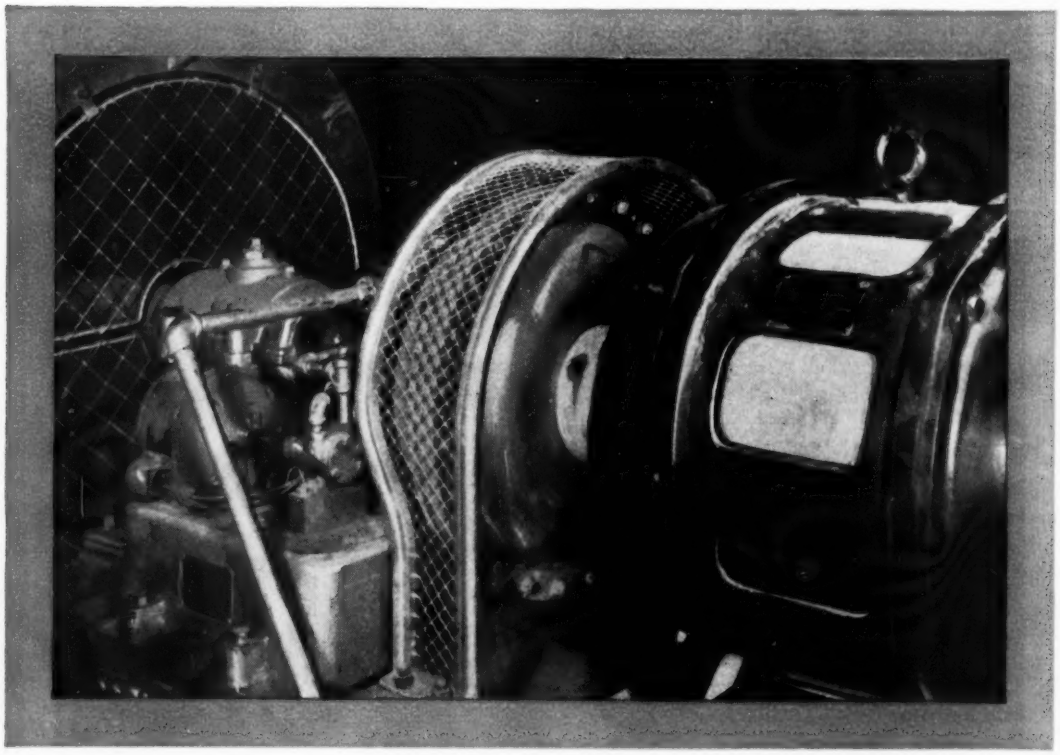
THIS ISSUE

Power Transmission and Speed Reduction

PUBLISHED BY
THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

Smooth

TRANSMISSION



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FOR HYDRAULIC POWER TRANSMISSIONS

LUBRICATION

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Power Transmission and Speed Reduction

A SPEED reducer introduces an intermediary between the prime mover and the unit to be driven which has become virtually indispensable to modern industry. High speed is the essence of economical power generation. The past few years have seen some remarkable developments in this regard but rarely, however, can these speeds be transmitted directly to production machinery. Be it the steam turbine, Diesel or electric motor, usually some step-down is essential to the best interest of the driven machine.

The modern variable speed transmission must be capable of instant adjustment; it must produce speeds which are commensurate with the productive ability of the machinery in question and these speeds must be so readily controllable as to promote maximum economy with regard to power consumption. In mechanics, speed, power and friction are intimately related. The latter materially controls the power consumption item and the maximum speed attainable. It is for this reason that builders of power transmission and speed reduction equipment have so actively studied the problem of lubrication and perfected such dependable systems for automatic circulation of lubricants.

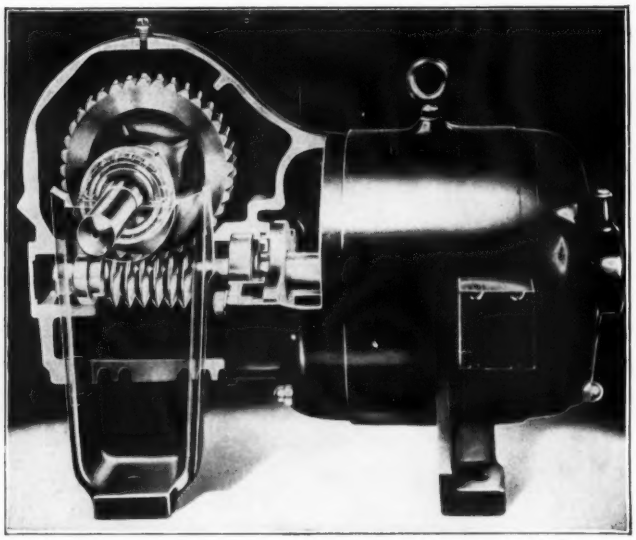
The variable speed transmission enables speed control to a most accurate degree. By employing the principles of the geared-head motor, hydraulic power or electro-mechanical means a wide range of mechanisms is available to industry for controlled speed, unit-drive purposes. The mechanical type of variable speed transmission involves an assembly of gears, belt connections or V-shaped pulleys. They are classified according to the manner in which speed control is effected. The geared motor, for example, has a definite set of selective gear ratios which can be readily changed to give a corresponding set of speeds at the driving end. The belt or V-type pulley transmission, in turn, gives a more flexible variation in the speed of both the driving and driven members simply by changing the distance between the sides of the pulleys.

Oil is the power transmitting medium in the hydraulic power transmission. This unit converts electric or mechanical power as delivered by a constant speed electric motor or other prime mover operating in one direction, into hydraulic power of variable speed. This can be accurately controlled or the direction reversed, irrespective of the direction of operation of the driving motor.

Hydraulic power is distinctive by reason of its adaptability to a wide variety of mechanical operations, which include the steering gear, hoists and windlasses in marine service, the automotive hydraulic brake, the automatic stoker in the power plant, paper mill machinery, the heavy duty press, the broaching machine, and numerous other high speed machine tools and pumping operations where flexibility of control is a factor.

GEARED MOTORS

The geared motor is applicable where a limited range of selective speed changes can be used and where floor space and first cost is a factor. With alternating current a mechanical means for speed reduction usually must be provided. Here the geared motor is an excellent medium. In particular, it has enabled the use of higher speed motor design which is less costly than the slow speed types of motors. The geared motor is available in a wide range of output speeds, and is used where no variation in operating speed is required.



Courtesy of The Master Electric Company

Fig. 1—Details of the Master right angle worm gear drive showing gear and bearing details.

Speed change within the unit itself is attained by means of a set of gears which mesh with a pinion mounted directly on the armature shaft or flexibly coupled thereto. There is a most convincing argument in favor of the geared motor due to the protection afforded lubrication, where operation is practicable. Within the available range of speeds, leakage of lubricant and entry of contaminating foreign matter are virtually eliminated in this device. So it is only necessary to be assured that the lubricant or lubricants used are best suited to the design and operating conditions. From this point on only periodic inspection will be necessary, with flushing and renewal of lubricant should operation have imposed a severe load. How often this should be done will depend upon the severity of the service.

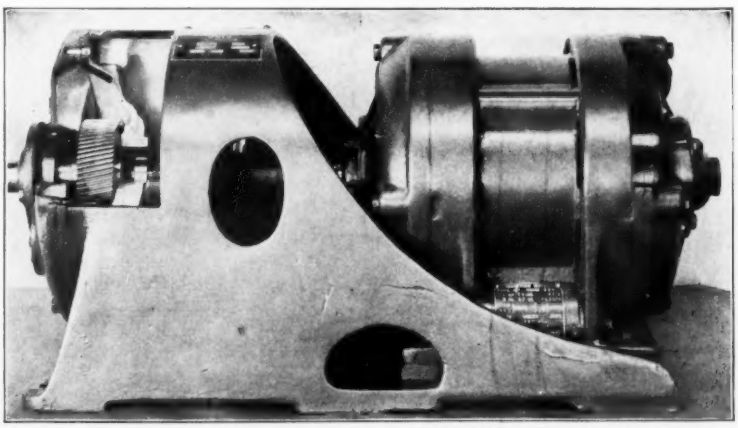
Bearing Design

The geared motor makes good usage of ball and roller bearings. Some are lubricated independently from the gear set; in others, the one lubricant serves all the interior moving parts.

Where sealed type ball bearings are used, a highly refined specially compounded grease of medium consistency will be suitable. It is very essential that such a lubricant be resistant to oxidation and breakdown, otherwise gum formation within the bearing elements may develop to increase the power consumption materially and perhaps ultimately to cause bearing failure if the balls or races should stick.

Gear Lubrication

The reduction gear set, however, is designed for oil lubrication, the oil being carried in the base of the gear case at a sufficient level to permit proper dipping of the lower gear, according to the accepted principles of bath lubrication. Experience has indicated that by reason of the comparatively fluid nature of the oil used, the lower gear should be about half submerged. The gear case should be filled to the oil level indicated on the outside of the unit.



Courtesy of Allis-Chalmers Manufacturing Company

Fig. 2—Cut-away of an Allis-Chalmers Gearmotor.

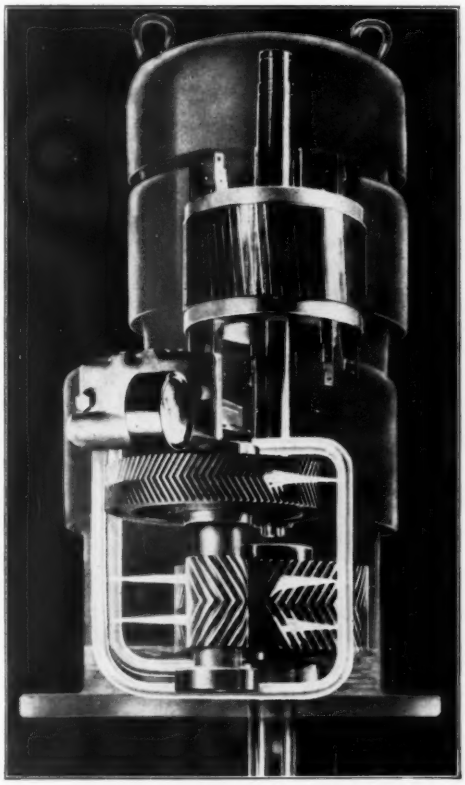
The viscosity of this oil should normally range from 500 to 900 seconds Saybolt at 100 degrees Fahr. In actual practice one must, of

course, decide on the most suitable viscosity only after careful consideration of the prevailing motor temperatures and the extent to which heat will be transmitted to the gear case or developed therein. There will always be a certain amount of temperature increase in any such installation. Radiation, however, will play an important part in preventing abnormal increase in gear case temperatures, according to the location. Where transmitted or induced temperatures are not severe, an oil of lower viscosity will probably develop less drag and internal power consumption.

V-BELT AND FLEXIBLE CHAIN TRANSMISSIONS

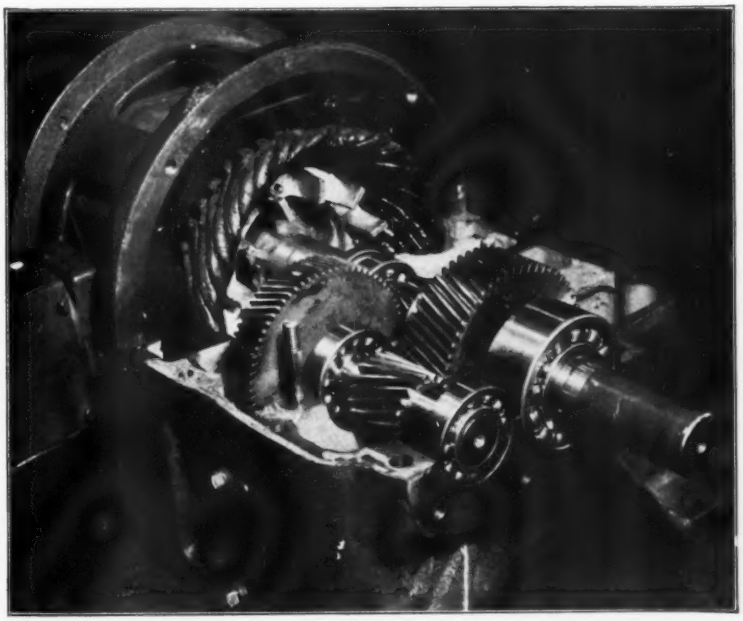
These units are built either open or enclosed, according to the prospective service and the importance of first cost. Open type installations are practicable where surroundings are comparatively clean. They can, furthermore, be readily adapted to limited space by mounting the motor on a platform above the transmission. Alignment and belt take-up in such a job can be made by changing the base location of the motor.

Wherever the motor forms an integral part of the transmission, it is located in an enclosed housing along with the transmission. This effectively reduces lubrication troubles, by preventing the entry of foreign matter. Power is transmitted by a flexible chain or V-shaped belt which forms the connection between the adjustable pulleys. Side contact prevails between these elements in contrast to the more conventional type of chain or belt drive installation wherein power is transmitted through face contact of the chain or belt with the sprockets or pulleys. The adjustable pulleys are built up from a set of opposed conical discs.



Courtesy of The Master Electric Company

Fig. 4—The Master gearhead motor showing oil flow (by gear pump) to each bearing, also the gear teeth.

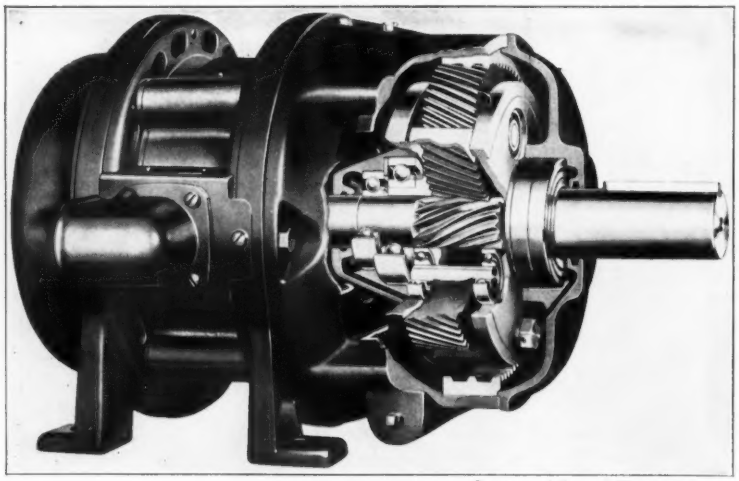


Courtesy of Westinghouse Electric and Manufacturing Company

Fig. 3—The Westinghouse Gearmotor with housing removed to show rotor, gear, and bearing details.

The speed of the connecting chain or belt is varied by changing the distance between the discs to change the effective radius of the arc over which the chain or belt is moving. This can be done under load without steps, and so gradually that jerky motion is entirely eliminated. Separation of one pair of discs simultaneously brings together the opposite pair. As a result, even though the speed of the driving shaft may always

be practically as constant as the speed of its driving motor, the speed of the driven shaft can be increased or decreased by altering the effective or driving diameter over which the connecting belt or chain is operating.



Courtesy of General Electric Company

Fig. 5—A General Electric squirrel-cage, induction type of single reduction gear-motor with housing cut away to show details of construction.

In the V-belt type of drive where smooth surface discs are employed, it is normally advisable to make speed changes or adjustment while the unit is in operation, in order to permit the belt to adjust itself to the surfaces of the discs. Such changes are made by hand by means of a suitable hand wheel located either on the transmission itself, or through a suitable crank and roller chain connection where the unit is inaccessible.

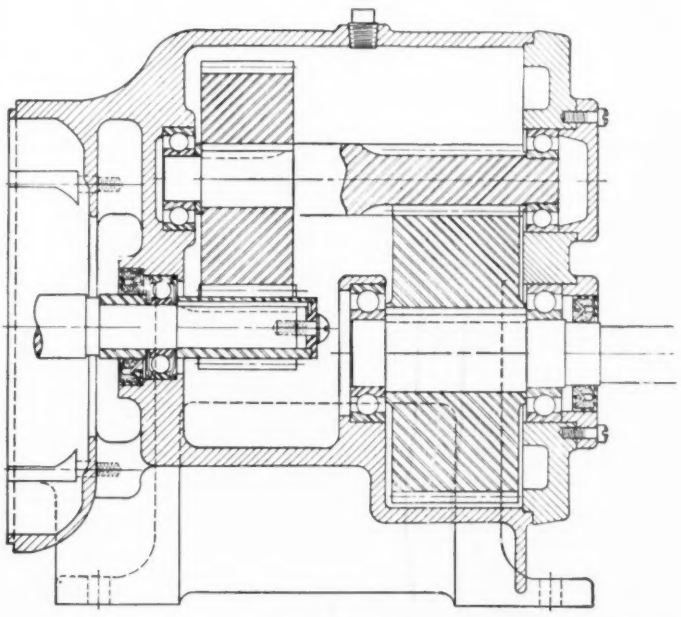
Lubrication Requirements

Where belts of fabricated rubber, leather or textile materials are used, lubrication is confined solely to the bearings which support the pulley shafts, and take up the thrust developed by the lateral pressure of the belts against the discs which compose the pulleys. There is no necessity for lubricant in the transmission case; in fact, the presence of lubricant on the face of the pulley discs is decidedly objectionable. For this reason, bearing construction in the interest of preventing leakage has been carefully studied, resulting in the widespread adoption of the seal-type ball bearing.

Flexible Chain Units

The chain elements in the flexible steel chain, however, require lubrication; likewise the disc surfaces with which the chain is in contact. So here we have a problem of chain as well as bearing lubrication. It is solved by use of a highly refined straight mineral oil. This lubricant also serves the ball bearings within the housing, which carry the wheel shafts and absorb the radial and thrust loads.

These bearings require less individual attention than the ball bearings in the V-belt transmission designed for grease lubrication by pressure gun. The same care must be observed, however, in regard to periodic flushing, to insure against accumulation of non-lubricating foreign matter. The primary purpose, of course, is to insure continuous and unimpaired rolling motion; this can be more successfully accomplished when the rolling elements are in proper alignment, with the minimum of deflection under load.

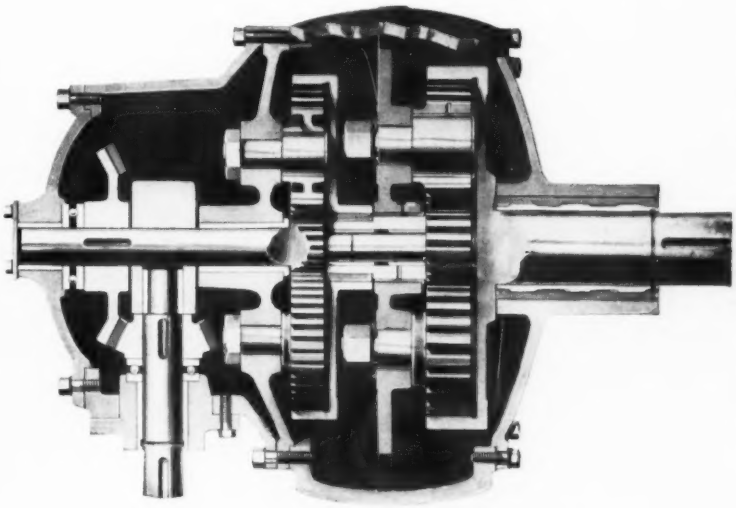


Courtesy of Century Electric Company

Fig. 6—The Century fractional horsepower gearmotor showing details of gear construction; the oil seals provide for durability and dependability.

Effect of Speed and Temperature

Speed and temperature are also factors. Both may vary widely in power transmission service. Low temperatures may lead to decidedly sluggish action in certain types of lubricants, with consequent increase in power consumption. In service where a comparatively fluid lubricant must serve both bearings and the parts which compose a flexible steel chain, it is obvious that abnormal drag within the lubricant itself may seriously affect the power transmitting ability of the entire unit.



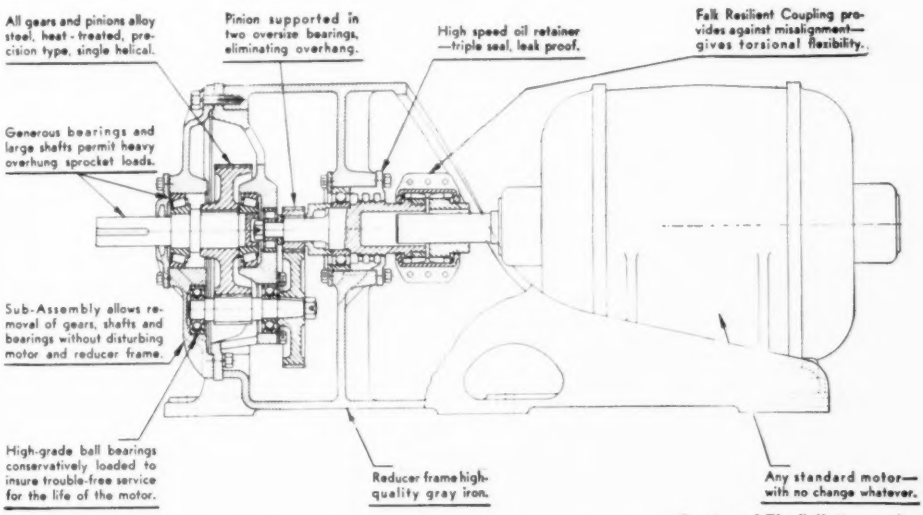
Courtesy of Foote Bros. Gear and Machine Corporation

Fig. 7—Showing how angle reduction can be applied to the Foote spur gear speed reducer.

It is usually necessary to use a higher viscosity oil for chain lubrication than will be required for a ball bearing under the same temperature conditions. In the latter, as speeds are increased, it is practicable to reduce the viscosity of the oil. Under extremely high speeds an oil as low as 100 seconds Saybolt at 100 degrees Fahr., has proved to be capable of giving adequate protection with a minimum of temperature increase.

In the variable speed transmission speeds do not range above normal electric motor speed, or in other words, above 4000 r.p.m. For such service an oil as low in viscosity as mentioned above would be out of line, both for bearings and chains, the minimum being perhaps around 300 seconds Saybolt at 100 degrees Fahr. A heavier oil will give greater protection of the pins, bushings and links which compose the chain, as it will resist the shock which is developed by engagement of the links with the teeth on the surface of the discs which compose the pulleys.

How detrimental these shocks will be to lubrication will depend upon the load, speed and constancy of operation. Rapid repetition upon the contact surfaces of the chains may prevent too light an oil from remaining be-

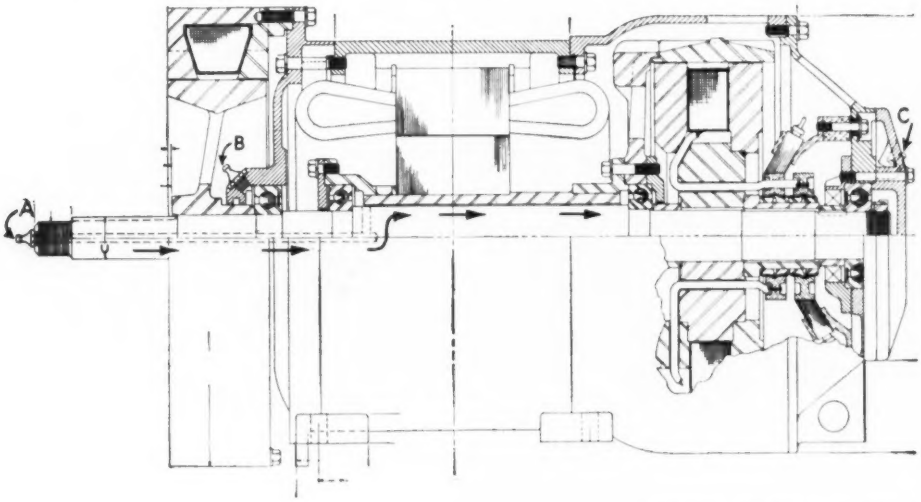

All gears and pinions alloy steel, heat-treated, precision type, single helical.
Pinion supported in two oversize bearings, eliminating overhang.
High speed oil retainer —triple seal, leak proof.
Falk Resilient Coupling provides against misalignment—gives torsional flexibility.
Generous bearings and large shafts permit heavy overhung sprocket loads.
Sub-Assembly allows removal of gears, shafts and bearings without disturbing motor and reducer frame.
High-grade ball bearings conservatively loaded to insure trouble-free service for the life of the motor.
Reducer frame high-quality gray iron.
Any standard motor—with no change whatever.

Courtesy of The Falk Corporation

Fig. 8—The Falk Motoreducer with essential parts indicated. Note in particular the leak-proof oil retainers.

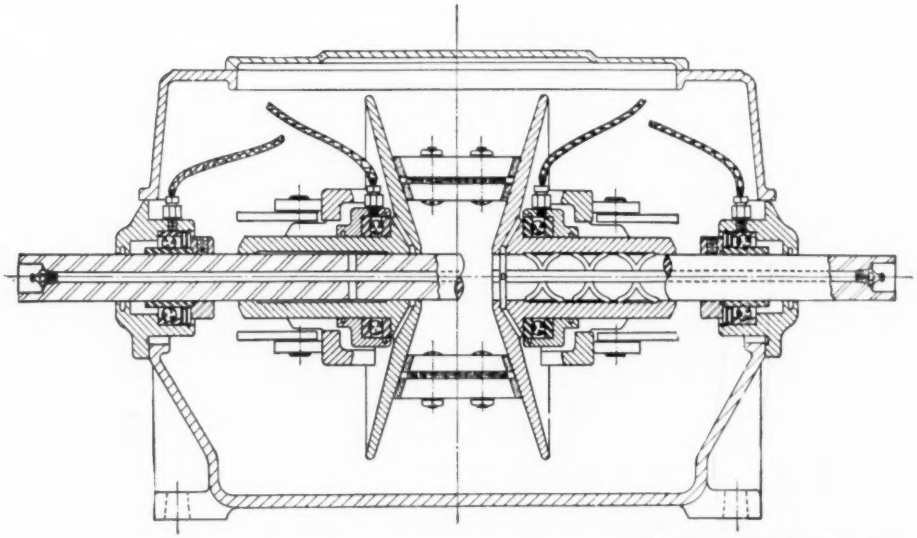
tween the chain leaves, pins and bushings, to result in wear and noisy operation. On the other hand, viscosity cannot be increased at will, inasmuch as the penetrative ability will vary directly with the relative fluidity.

Bending or articulation is the chief cause of wear in the flexible steel chain. This wear may occur on the parts which compose the chain and which move with respect to each other, or it may develop at the points of contact between the chain and its companion pulleys. Splash lubrication has been widely adapted to overcome this possibility. It is applicable to the oil-tight nature of the housing and the normal viscosity of oil which must be used to protect both the chains and bearings. In service the entire mechanism functions in a veritable fog of oil being thoroughly protected against entry of abrasive foreign matter. When a highly refined straight mineral oil is used, which is of sufficient body to maintain a pressure-resisting film and yet so fluid as to penetrate readily through the chain and bearing parts, there should be no difficulty from a



Courtesy of The Louis Allis Company

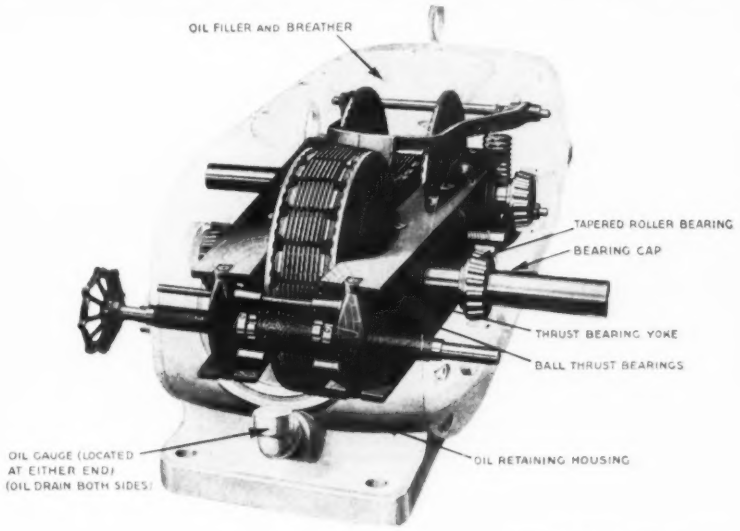
Fig. 9—The Louis Allis Adjusto-Spede Motor. Points A, B, and C indicate grease lubrication fittings, path of lubricant (through the drilled rotor shaft) being shown by arrows.



Courtesy of Reeves Pulley Company

Fig. 10—Showing the lubrication of the enclosed type of Reeves variable speed transmission, by means of pressure grease fittings, to protect the ball bearings.

lubricating viewpoint. In continued service, however, or when the transmission is operating under moisture, chemical or dust conditions, periodic cleaning is advisable.


OIL FILLER AND BREATHER
TAPERED ROLLER BEARING
BEARING CAP
THRUST BEARING YOKE
BALL THRUST BEARINGS
OIL GAUGE (LOCATED AT EITHER END) (OIL DRAIN BOTH SIDES)
OIL RETAINING HOUSING

Courtesy of Link-Belt Company

Fig. 11—Phantom view of the Link-Belt P.I.V. variable speed transmission. This drive is entirely enclosed and automatically lubricated with oil.

Grease Lubricated Ball Bearings

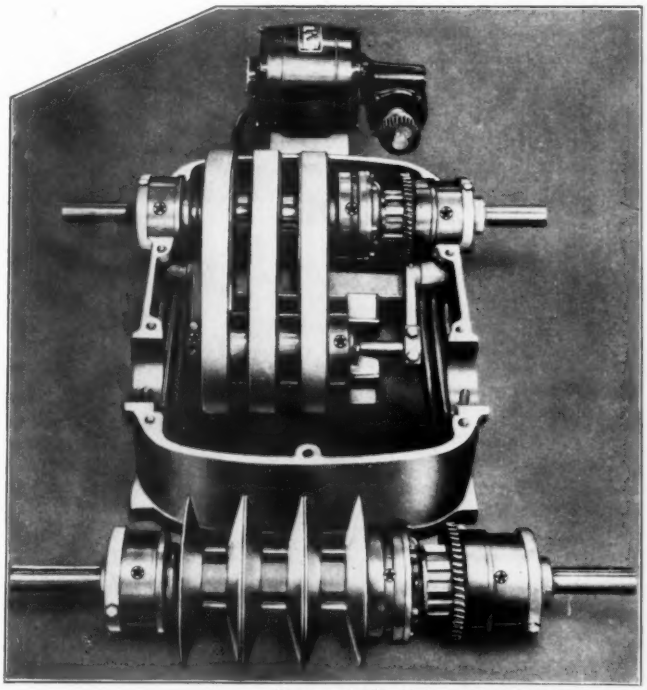
Pressure grease lubrication is required on these bearings in the V-Belt Transmission. Their construction includes suitable sealing media to prevent leakage of grease, and the possibility of contact with the power transmitting surfaces of the belts. Grease, in itself, is also an effective sealing medium provided it is of suitable body.

In a device such as the variable speed transmission, however, it is best to rely on mechanical means of sealing the bearings, for heavy greases may lead to abnormal power consumption. So a grease of low torque characteristics and medium consistency, capable of functioning under comparatively high temperatures is regarded as best suited to the service involved.

Re-Lubrication

The method of application when re-lubrication is necessary is worthy of consideration. The builders of variable speed power transmission units have largely adopted the pressure grease gun for ball bearing lubrication, suitable fittings for attachment of same being located on the bearing housings or connected thereto. This method of pressure lubrication is accepted as being highly efficient in protecting bearings capable of retaining a grease charge without leakage. The gun must be carefully handled, however, otherwise too much grease can be forced into the bearing housing.

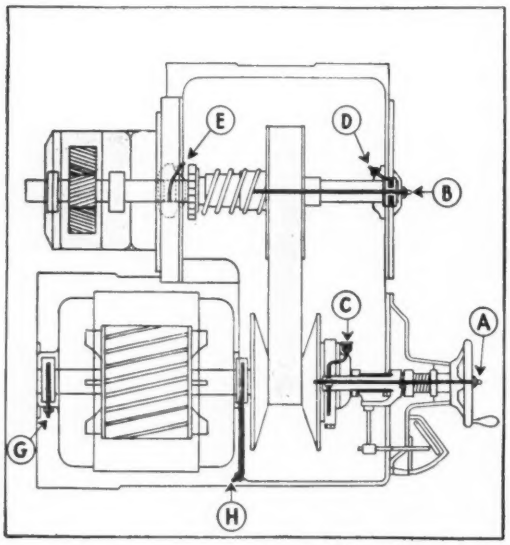
This may readily lead to overheating, especially if the grease is too heavy, as the result of excessive internal friction within the lubricant itself. With certain types of grease, abnormal increase in temperature may cause sufficient decrease in body to result in separation of the oil from the soap, thereby causing marked reduction in lubricating value and loss of oil by leakage if the bearing is not oil-sealed. In the variable speed transmission, this might also result in oil dripping or



Courtesy of Allis-Chalmers Manufacturing Company

Fig. 12—Looking down on the Allis-Chalmers vari-pitch speed changer. Note use of the Texrope multiple V-belt drive in this unit; also grease-lubricated ball bearings as indicated by stars.

being thrown on to the V-belt to impair the fabric and reduce the traction effect on the pulleys.



Courtesy of Reeves Pulley Company

Fig. 13—A view of the Reeves Vari Speed Motodrive showing the pressure grease lubrication fittings at A, B, D, E, G, and H, and a cup-type at C.

Exposed bearings can be felt periodically when they appear to be hot. The conclusion may often be drawn that increase in temperature is due to lack of lubrication. On the other hand, where a bearing runs warm due to too heavy a grease, addition of more grease will only aggravate conditions. There will also be the danger of forcing some grease past the seals. So, operators should be carefully educated to the lubricating requirements of ball and roller bearings, just as the management should be impressed with the folly of purchasing unsuitable products, chiefly on a price basis. Bearings of this type have but a limited capacity for grease, which should never be exceeded, and this grease should be of the highest quality.

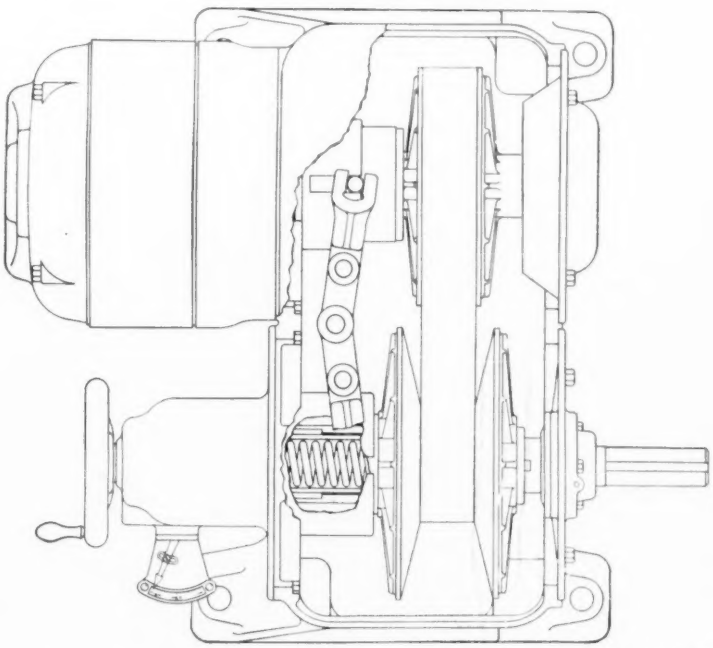
There is no direct method by which application of grease to anti-friction bearings can be controlled. Certain types of bearings, however, can be vented to reduce the possibility of imposing the full pressure of the lubricating equipment upon the seals; these latter must of course be maintained in suitable condition with respect to the housing if they are to positively prevent leakage of lubricant under continuous operation.

Type of Grease

A grease for ball or roller bearing lubrication must be practically free from acid-forming tendencies if positive protection of the highly polished metallic surfaces is to be maintained. This necessitates a virtually neutral product and one which contains no fillers. The grease must also show minimum tendency towards oxidation, decomposition, separation and development of free acidity, otherwise corrosion or pitting of the surfaces of the rolling elements may result.

For bearing lubrication in electric motor or variable speed transmission service, a grease compounded from a medium viscosity, highly refined, straight mineral oil and a soap which is suitable to comparatively high temperature service will give lowest starting and operating torque and best assurance against separation, oxidation and gum formation.

HYDRAULIC PUMP AND MOTOR LUBRICATION

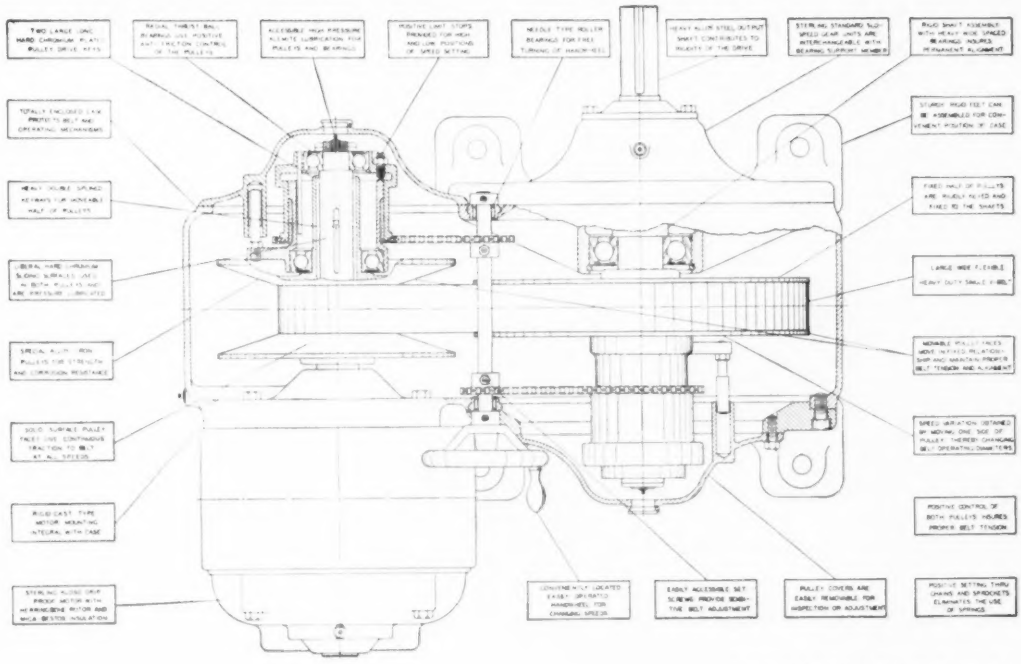


Courtesy of U. S. Electrical Motors, Inc.

Fig. 14—Showing the details of the U. S. Varidrive Motor. This unit is also equipped with grease-lubricated ball bearings via pressure gun fittings.

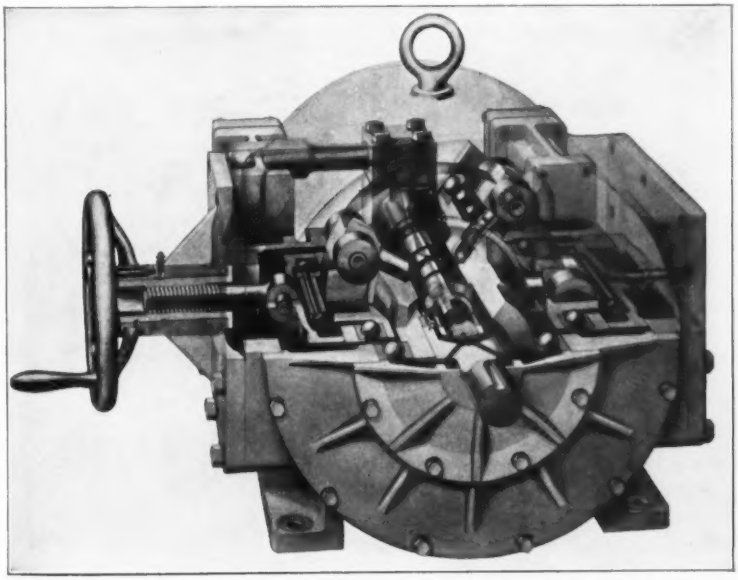
The designers of hydraulic power transmission units provide for a certain amount of leakage of oil through the hydraulic pump and

motor in order to provide for complete lubrication. According to the design, this leakage takes place between the face of the cylinder barrel and face of the valveplate, or past the plungers or packless pistons and valve to be held in the races of the floating ring by centrifugal force. As the oil is under considerable pressure, whenever the mechanisms are functioning, it is expected that there will be a sufficient film between all working surfaces of the pistons, plungers, cylinder barrel and valve unit, provided the oil temperature range is properly controlled.



Courtesy of Sterling Electric Motors, Inc.

Fig. 15—The Sterling enclosed type Speed-Trol motor showing pulley and belt arrangement, the grease-lubricated ball bearings on the pulley shafts, and the speed control device.



Courtesy of Northern Pump Company

Fig. 16—The Northern radial piston pump for hydraulic power transmission.

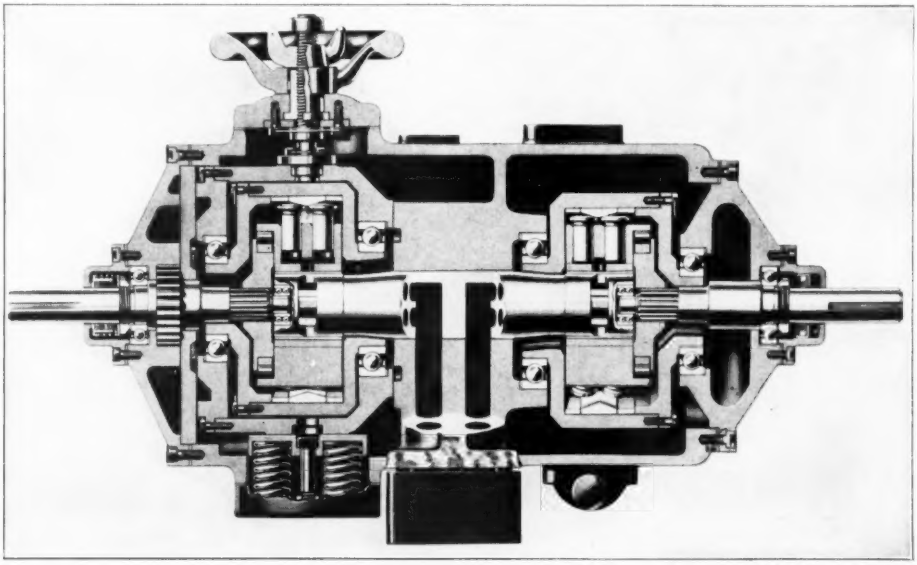
Leakage of oil or working fluid of course results in a certain reduction in effective displacement of the pump, which can be noted at the motor end by the effect on speed or revolutions. Obviously it will affect the ultimate efficiency of the entire transmission. This will not be noticeable unless the unit is employed in power transmission service where very accurate speed control is of importance, as for example in the paper industry.

There is no loss of oil, however, even though there is leakage within the pump and motor mechanisms, for that oil

which serves to lubricate is drained from the pump and motor cases into a suitable reservoir located in the bedplate of the unit or elsewhere according to the location of the transmission.

Indications of Impaired Lubrication

Faulty lubrication due to too thin an oil will be indicated by inability to develop and hold the desired pressure, overheating of the pump,

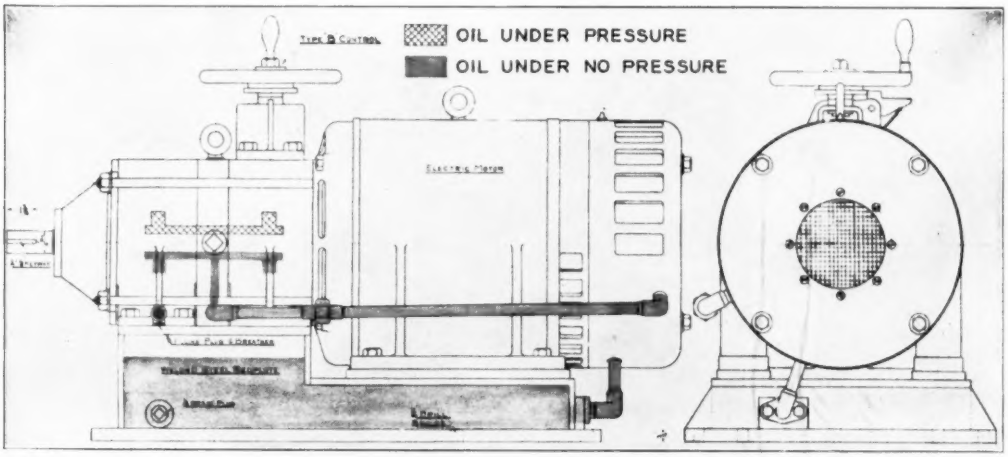


Courtesy of The Oilgear Company

Fig. 17—Plan view section of an Oilgear type D.S.C. variable speed transmission.

In the operation of paper mill machinery where the pumps are often located apart from the fluid motors and connected to same by suitable piping systems, the leakage oil is drained from the cases into a common oil reservoir in the basement. From here it is transmitted to a filter or purifier, after which it is pumped back to the suction side for recirculation.

or reduction in power output. Lack of sufficient oil in the system will be indicated by noisy operation and lack of positiveness in the drive due to presence of air or gassified oil.



Courtesy of American Engineering Company

Fig. 18—View of the Hele-Shaw transmission adapted to air cooling by a fan driven from the outboard end of the electric motor. Oil under pressure is indicated by crosshatching. Oil level and piping for oil under no pressure to and from the cooling element and to the pump is shown in gray.

Freedom from Air Essential

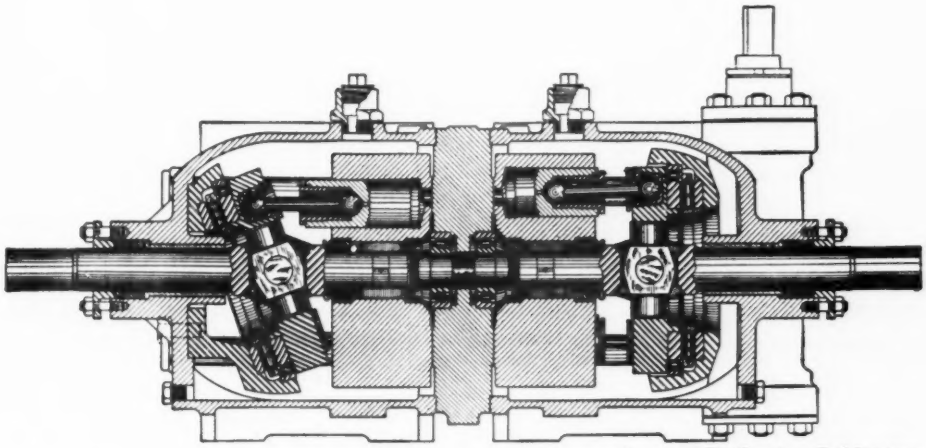
An hydraulic power transmission system functions at its best when entirely filled with oil and as free as possible from air. For this

reason, filling of the system requires considerable care and attention. Those who are familiar with the instructions issued by motor car builders relative to use of hydraulic fluid in hydraulic brakes, are fully aware of the benefits attendant to this procedure.

Air will most usually gain entry at the time of filling the transmission with oil, unless there may be leakage at some high point in the system, or between the tank and pump. Normally, however, any aperture capable of leaking air will also allow oil to pass out, more easily freed from air than heavier products. It is important to bear this in mind when first running the pump after filling with oil, the time of running being gauged according to the viscosity of the oil. Normally this must be determined by experience.

The expansion tank also serves as a reservoir to insure that there is sufficient oil in the system, the level of the latter being as an indication as to when refilling may be necessary.

Considerable care must also be observed to prevent entry of abrasive foreign matter at



Courtesy of The Waterbury Tool Company

Fig. 19—Section through a type C Waterbury transmission where pump and motor are combined. B—end is shown at the left, with A—end on the right.

especially when the pump is operating at full stroke. Entry of air may also be caused by leaky packing, restriction of the pump intake, which may be caused by sludge accumulations, or location of this inlet above the surface of the oil in the tank. The latter may frequently occur if the oil is being rapidly circulated through the system.

Entry of air at the time of filling cannot be prevented entirely. It can, however, be materially reduced by adding make-up oil very slowly and where practicable straining through one or two thicknesses of cheesecloth. Subsequent formation of air pockets can be eliminated by locating suitable air relief valves at certain of the high points in the pipe connections as well as at the top of the expansion tank. After filling with oil, if the pump is run for a certain length of time, any entrained air will gradually work its way out of the oil in circulation and into the base of the pump housing, from whence it will rise to the expansion tank after the pump is shut down. Removal of such air can also be accelerated by locating a baffle plate in the oil tank. This will develop a certain amount of surging and facilitate rise of air bubbles. Lighter oils can be

the time of filling the transmission. One must realize that the contact surfaces of the working elements of both pump and fluid motors are machined to a high degree of accuracy. Presence of abrasives in the oil supply, or acids, which may have been used in pickling of piping or connections, may easily lead to scoring or pitting of the pressure surfaces, or ruination of the accuracy of the ball or roller bearings.

Adequate cleaning of all piping and accessory parts at the time of assembly will assure against presence of pickling acids. Later, when filling with oil, if a highly refined straight mineral oil is used, with due care in handling, the possibility of entry of abrasive foreign matter or formation of sludge should be reduced to a minimum.

Oil Cooling

The temperature of the oil as returned to the pump must never be allowed to become too high, due to the very serious effect which it may have upon lubrication, especially where this latter must be maintained between bronze and steel. To this end provision is made where necessary for adequately cooling the oil after it has passed through the pump and motor, before

it is returned to the former. Recommended practice is to regulate the cooling system so as to reduce the oil temperature to at least 110 degrees Fahr.

Some types of systems will develop less heat than others. The volumetric type of pump frequently has the advantage in this regard. Obviously minimum heat generation within the system is advantageous in that more constant viscosity of the oil will be maintained with more positive assurance of effective lubrication. Reduction in heat developed also precludes abnormal vaporization in certain types of oil. This is of distinct advantage in that possibility of carbon formation is also reduced.

Cooling can be accomplished by water or air. Until recently the former has been most prevalent, cooling coils being installed in the oil reservoir or supply tank, with suitable water connections. Latest developments, as applied to installations where the electric motor is virtually an integral part of the pump, provide for location of oil piping surrounded by cooling fins at the outboard end of the electric motor. A fan attached to the rotor adjacent to these coils passes a current of fresh air constantly over the cooling element to reduce the temperature of the oil, unless the room temperature is abnormally high.

Discussion of the detrimental results which may accrue from pumping hot oil will be of interest. Obviously, there will be a reduction in the viscosity or body of the oil, dependent upon the temperature. Along with this reduction in viscosity, the pressure-resisting ability of the oil film will be decreased. Considering that at certain stages of the stroke of any such pump there will be severe thrust pressures developed, it is evident that an overheated oil film may become so weakened as to be incapable of actually preventing metal-to-metal contact. Where this occurs between bronze and steel, the latter may develop a wiping effect, the bronze being virtually melted or burned onto the opposing steel surface. This will necessitate considerable expensive overhaul and parts replacement.

In connection with oil cooling, careful consideration must be given to the arrangement and tightness of the water cooling system, due to the detrimental effect which water leakage may have on lubrication. This is one of the chief reasons for recommendation of the use of oils of very high degree of refinement. Presence of any appreciable amount of water may lead to formation of emulsions with certain types of oil. In a closed system, such as an hydraulic power transmission system, where there is normally but little opportunity for the oil to rest and separate itself from water emulsions, oxidation may develop with subsequent sludge formation. All this will be aggravated under the higher temperatures which are developed during pumping and circulation.

Sludge is a distinct detriment to lubrication, for it will tend to accumulate in clearance spaces, ports or other small apertures in the pump, to interfere with free flow and leakage of the oil past those parts which require a lubricating film. Sludge accumulations in some oils may also be conducive to acidity, which may lead to corrosion of ball or roller bearing elements and other highly polished parts.

Oil Characteristics

So manufacturers of hydraulic power transmission machinery are agreed that only lubricating oils of a very high degree of refinement should be used. It is especially important that they be entirely free from abrasive or contaminating foreign matter. High demulsibility, or an ability to separate readily from water, is not always essential, however, unless the system may be subjected to a considerable water leakage. On the other hand, low oxidizing and carbon-residue forming tendencies are most important characteristics. They will normally be indicative of the durability of the oil and a guide to its resistance to breakdown.

Viscosity, in turn, is of importance as an indication of body or relative fluidity. According to the make of pump, manufacturers' recommendations will range from 140 to 1200 seconds Saybolt at 100 degrees Fahr. High pumping pressures and operating temperatures will call for heavier oils, the range depending upon the type of system, the extent to which pipe lines may be restricted, and the necessity for keeping down pipe line head loss. Oilgear advises the use of an oil of approximately 320 seconds Saybolt universal viscosity at 100 degrees Fahr. for general service; they specify lighter oils of around 140 viscosity where temperatures between 30 and 45 degrees Fahr. prevail. The builders of the Hele-Shaw pump, in turn, prefer an oil of approximately 1000 seconds Saybolt at 100 degrees Fahr., for maximum pressure operations or where high temperatures prevail. A viscosity of 500 to 600 is satisfactory for pressures up to 1500 lbs. per square inch. The Waterbury hydraulic system requires an oil of medium viscosity, i.e. in the neighborhood of 320 seconds Saybolt at 100 degrees Fahr. Northern, in turn, has adopted a range in regard to viscosity dependent upon peak pump pressures and duty cycle which directly affects the temperature of the oil. This range will generally run from 500 to 1200 seconds Saybolt at 100 degrees Fahr.

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TEXACO LUBRICANTS

FOR VARIABLE SPEED TRANSMISSIONS

GEARED MOTORS

PLAIN BEARINGS

Oil Lubricated	TEXACO Canopus, Nabob, or Aleph Oils
Grease Lubricated	
(Low or medium temperature)	TEXACO Star Grease No. 1
(High temperature service) .	TEXACO Marfak No. 2

BALL OR ROLLER BEARINGS

Independently lubricated (according to speed or temperature)	TEXACO Marfak No. 2, or TEXACO Starfak Grease No. 2
BUILT-IN GEARS	TEXACO Altair or Aries Oils, or TEXACO Thubans

VEE-BELT TRANSMISSIONS

BEARINGS OF MOTORS AND DISC PULLEYS

Grease Lubricated (according to speed and temperature) . .	TEXACO Marfak No. 2, or TEXACO Starfak Grease No. 2

FLEXIBLE CHAIN TRANSMISSIONS

BEARINGS OF MOTORS AND DISC PULLEYS

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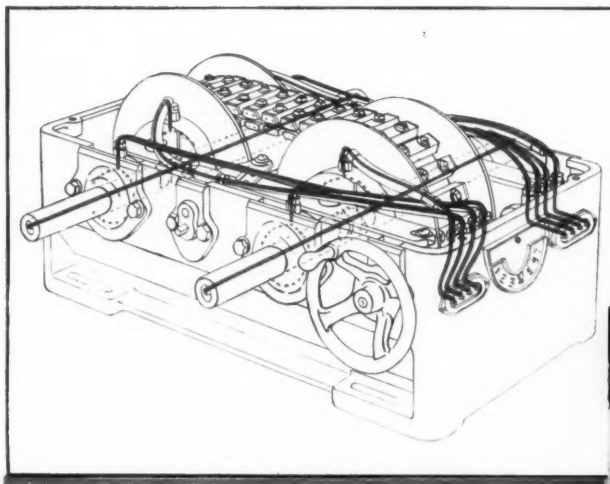
TRANSMISSION CHAINS

Temperatures below 40° F. . .	TEXACO Algol, Ursa Oil, or TEXACO Ursa Oil Medium Heavy
Normal Temperatures	TEXACO Ursa Oil Heavy, or TEXACO Vanguard Mineral Cylinder Oil
Temperatures above 100° F. .	TEXACO Gear Oil W

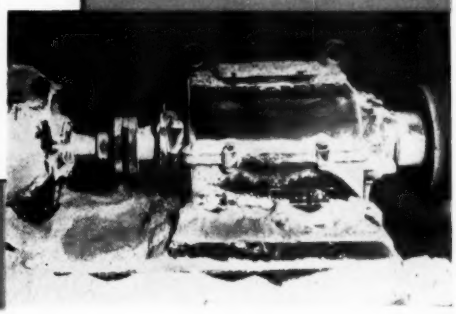
HYDRAULIC POWER TRANSMISSIONS

TEXACO Regal Oils or TEXACO Ursa Oils, according to manufacturers' specifications.

EFFICIENCY UP...



(Left) Showing a **REEVES** enclosed type of variable speed-mechanism with cover removed to indicate lubrication piping. Anti-friction bearings in this and other types of speed reduction mechanism keep operating at top efficiency when lubricated with Texaco Starfak Grease.



(Right) **LINK-BELT** speed reducer operating continuously in spite of heavy abrasive dust. Texaco Starfak Grease helps seal out dust and dirt, gives efficient lubrication under all conditions.

LOWER STARTING and running torque, higher efficiency are brought about through the installation of anti-friction bearings in today's modern speed reducers.

To maintain these advantages and keep the bearings operating properly over long periods, a special lubricant is required. After years of intensive research on lubricants for this particular purpose Texaco engineers developed Texaco Starfak Grease.

Texaco Starfak Grease is stable, resists break-down, separation or leakage. It helps seal the bearings against dust and dirt. Texaco Starfak Grease maintains its consistency over wide temperature ranges assuring constant lubrication, improved bearing performance and reduced wear under heavy loads.

Trained Texaco lubrication engineers will gladly cooperate in the selection and application of proper grade of Texaco Starfak for any type of anti-friction bearings. To get this service, phone the nearest of our 2279 warehouses, or write:

TEXACO's new 44-page booklet covering the construction, installation, lubrication of anti-friction bearings. Free on request.

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